US009165038B1

(12) United States Patent
Van Dijk et al.

(10) Patent No.: US 9,165,038 B1
(45) Date of Patent: *Oct. 20, 2015

(54) INTERPRETING ADJACENT SEARCH TERMS BASED ON A HIERARCHICAL RELATIONSHIP

(71) Applicant: **Google Inc.**, Mountain View, CA (US)

(72) Inventors: **Luuk Van Dijk**, Zurich (CH); **Ivan Zauharodneu**, Zurich (CH)

(73) Assignee: **Google Inc.**, Mountain View, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/290,230**

(22) Filed: **May 29, 2014**

Related U.S. Application Data

(63) Continuation of application No. 13/452,179, filed on Apr. 20, 2012, now Pat. No. 8,745,028, which is a continuation of application No. 12/345,366, filed on Dec. 29, 2008, now abandoned.

(60) Provisional application No. 61/016,916, filed on Dec. 27, 2007.

(51) **Int. Cl.**
G06F 17/30 (2006.01)

(52) **U.S. Cl.**
CPC ***G06F 17/30522*** (2013.01); ***G06F 17/30106*** (2013.01)

(58) **Field of Classification Search**
CPC G06F 17/30734; G06F 17/30675
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,934,634	B1	8/2005	Ge	
7,788,265	B2	8/2010	Morscher et al.	
7,822,734	B2 *	10/2010	Kumar	707/708
8,135,737	B2	3/2012	Chowdhury et al.	
8,745,028	B1	6/2014	Van Dijk et al.	
2004/0194141	A1 *	9/2004	Sanders	725/53
2004/0199498	A1 *	10/2004	Kapur et al.	707/3
2006/0004747	A1 *	1/2006	Weare	707/5
2006/0085392	A1 *	4/2006	Wang et al.	707/3
2006/0122994	A1	6/2006	Kapur et al.	
2007/0260595	A1	11/2007	Beatty et al.	
2008/0104047	A1	5/2008	Nagarajayya	
2009/0144241	A1	6/2009	Modzelewski	

OTHER PUBLICATIONS

An et al., "Fuzzy Concept Graph and Application in Web Document Clustering," Object Technology Center, Institute of Software, The Chinese Academy of Sciences, 2001, pp. 101-106.

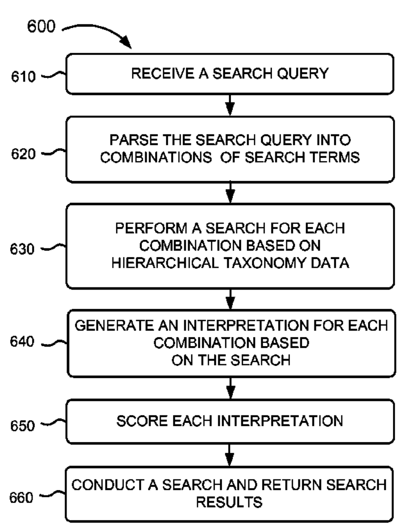
(Continued)

Primary Examiner — Dinku Gebresenbet
(74) *Attorney, Agent, or Firm* — Harrity & Harrity, LLP

(57) **ABSTRACT**

A computer-implemented method may include receiving, from a device, a search query that includes search terms, parsing the search terms into combinations of search terms, where each of the combinations includes one or more adjacent search terms, determining whether a hierarchical relationship exists for the one or more adjacent search terms of each of the combinations, generating one or more interpretations for each of the combinations based on whether the hierarchical relationship exists for the one or more adjacent search terms, performing a search based on at least one of the one or more interpretations to identify search results, generating a search result document containing the search results, and providing, to the device, the search result document.

20 Claims, 7 Drawing Sheets



(56) **References Cited**

OTHER PUBLICATIONS

Kawano, "Overview of Mondou Web Search Engine Using Text Mining and Information Visualizing Technologies," Department of Systems Science Graduate School of Informatics, Kyoto University, Japan, 2001, pp. 234-241.

Chung et al., "Thematic Mapping—From Unstructured Documents to Taxonomies," Verity, Inc., 2002, pp. 608-610.

Osborn et al., "Justice: A Judicial Search Tool Using Intelligent Concept Extraction," Department of Computer Science and Software Engineering, University of Melbourne, Australia, 1999, pp. 173-181.

* cited by examiner

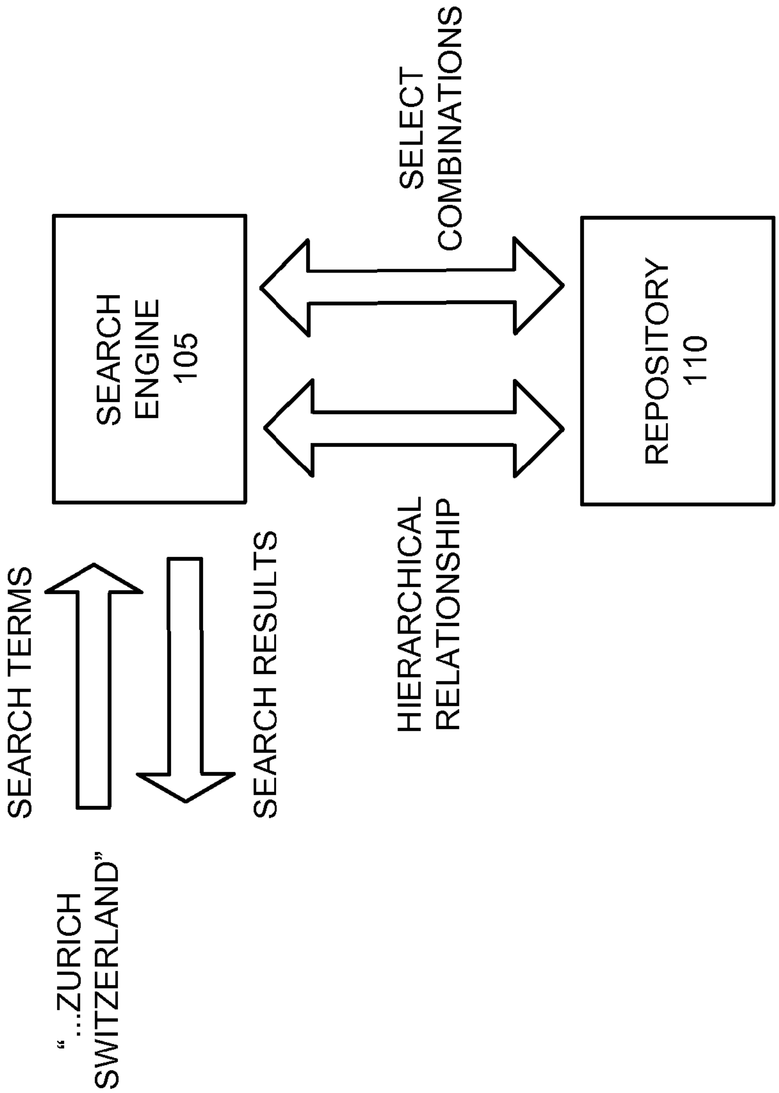

SEARCH ENGINE 105
REPOSITORY 110
SELECT COMBINATIONS
HIERARCHICAL RELATIONSHIP
SEARCH TERMS
SEARCH RESULTS
"...ZURICH SWITZERLAND"

FIG. 1

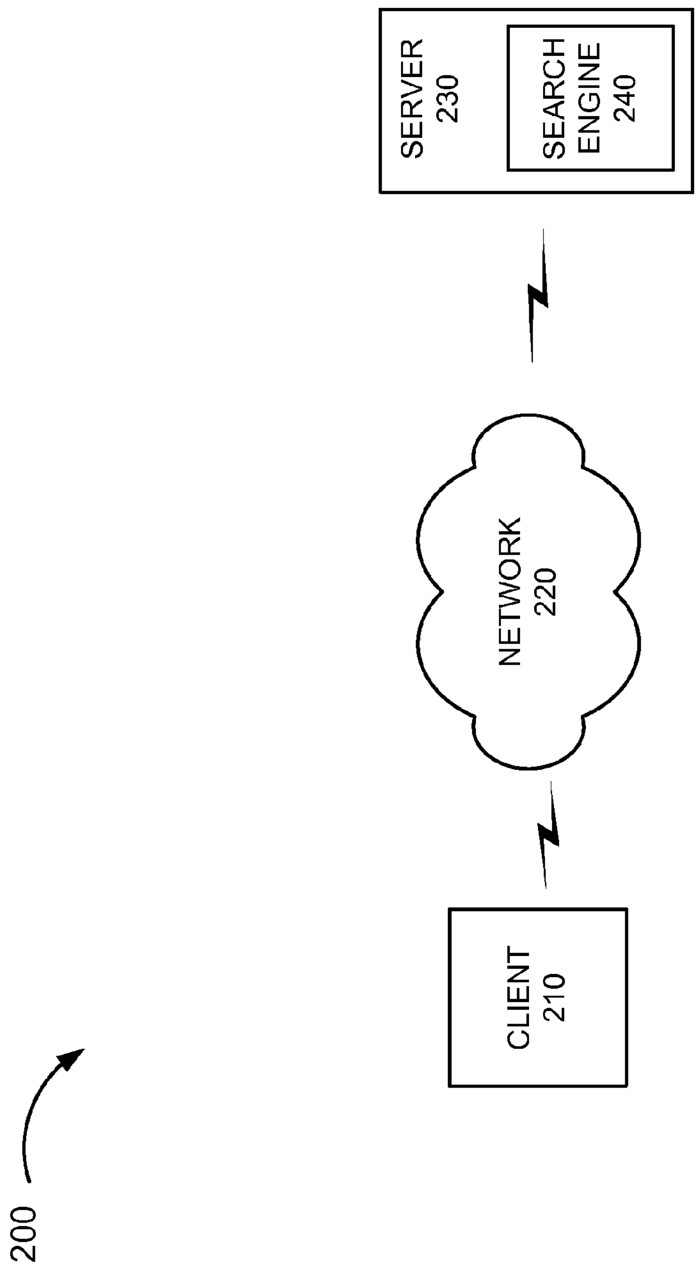


FIG. 2

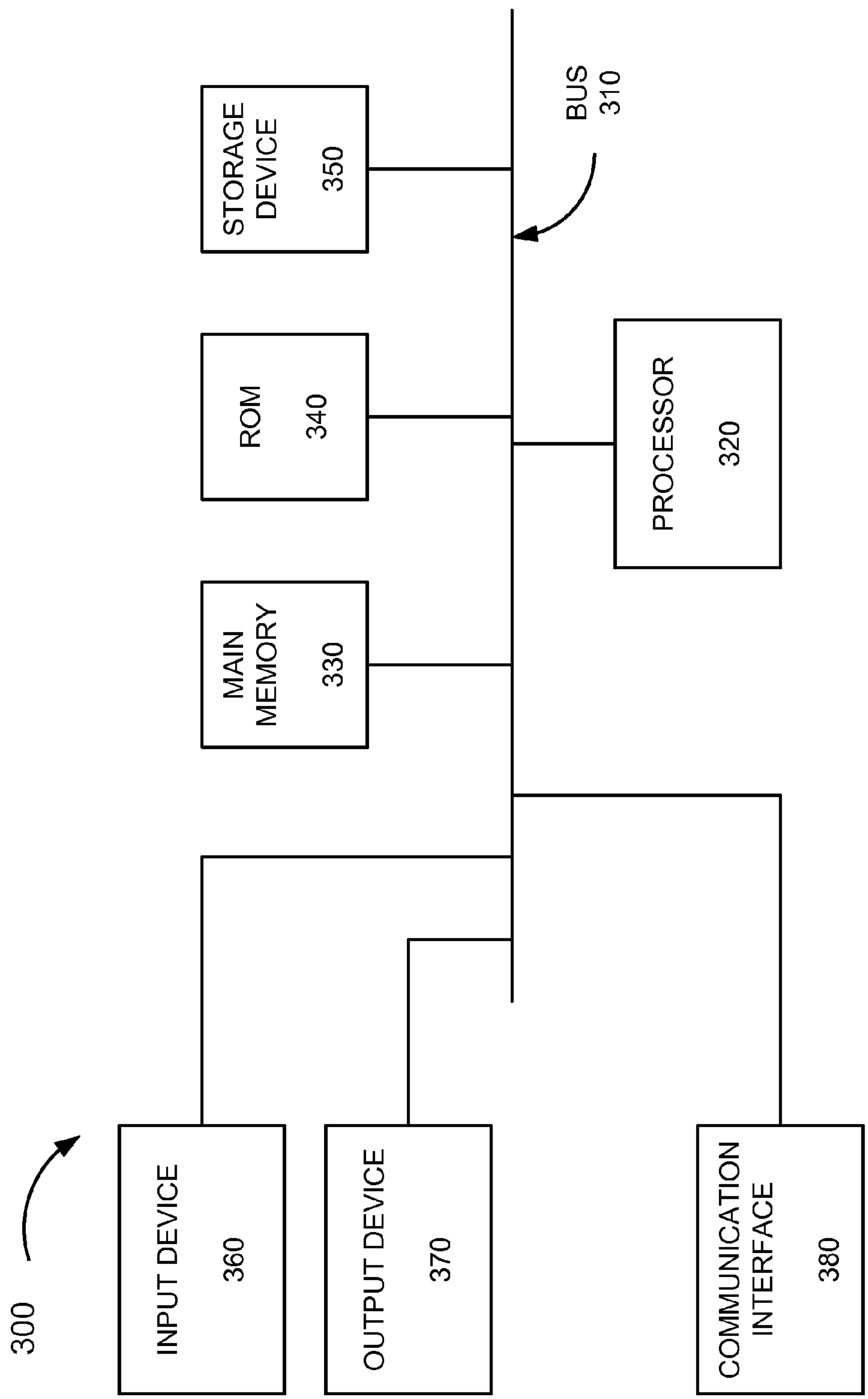

300
INPUT DEVICE 360
OUTPUT DEVICE 370
COMMUNICATION INTERFACE 380
MAIN MEMORY 330
ROM 340
STORAGE DEVICE 350
PROCESSOR 320
BUS 310

FIG. 3

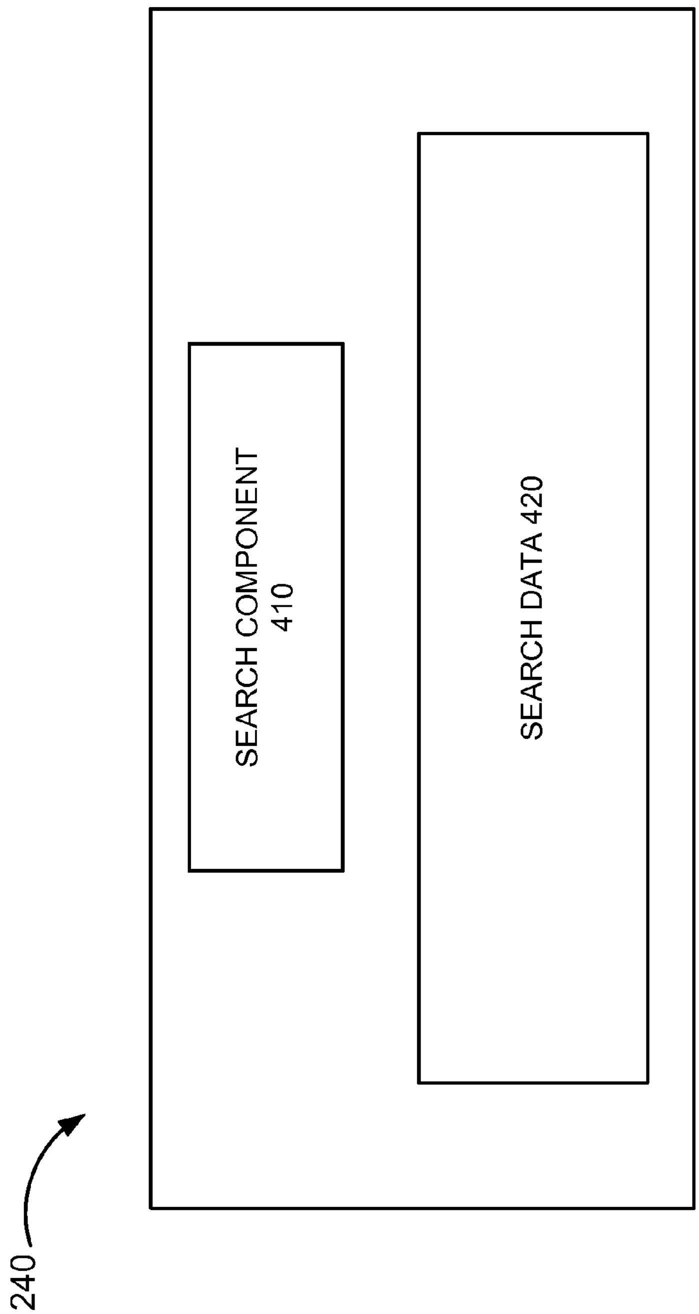


FIG. 4

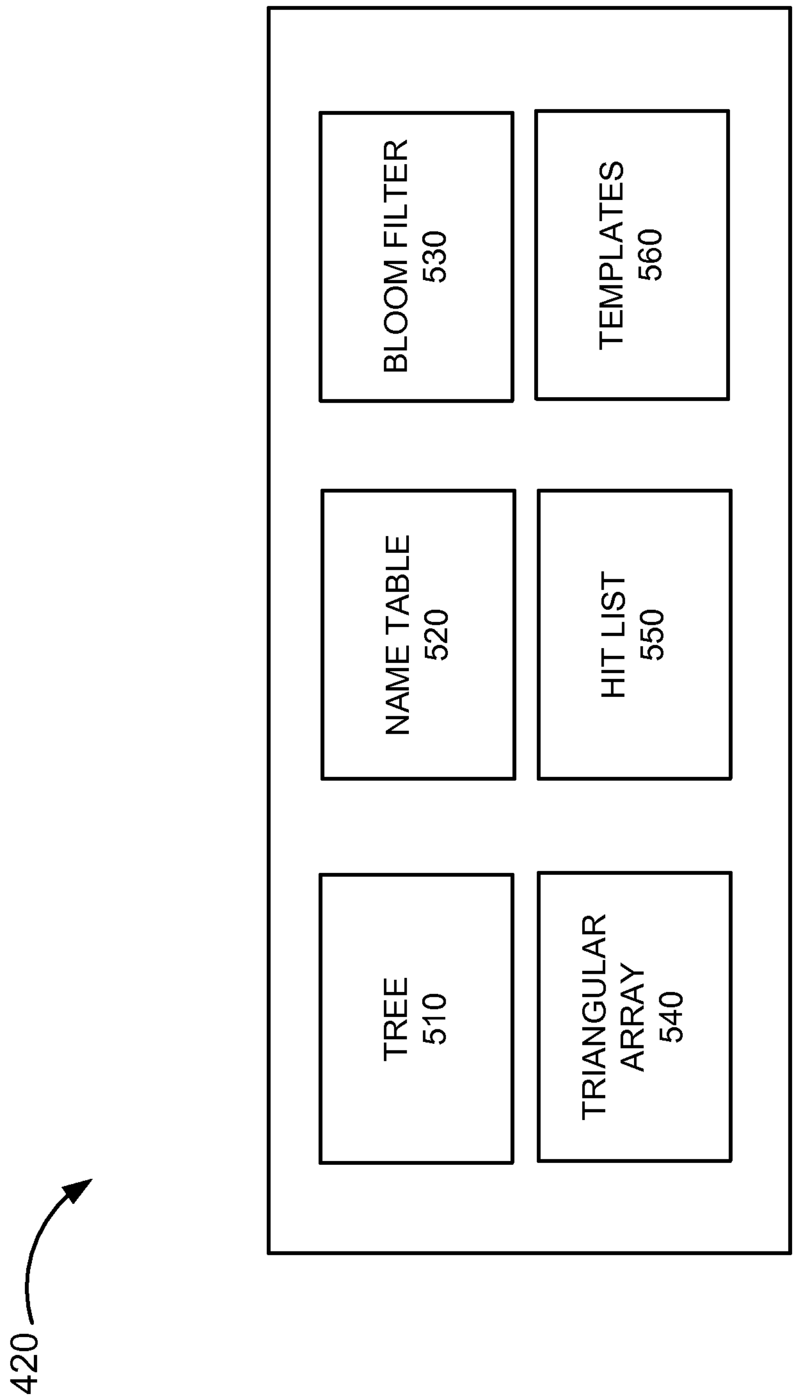

420
TREE 510
NAME TABLE 520
BLOOM FILTER 530
TRIANGULAR ARRAY 540
HIT LIST 550
TEMPLATES 560

FIG. 5

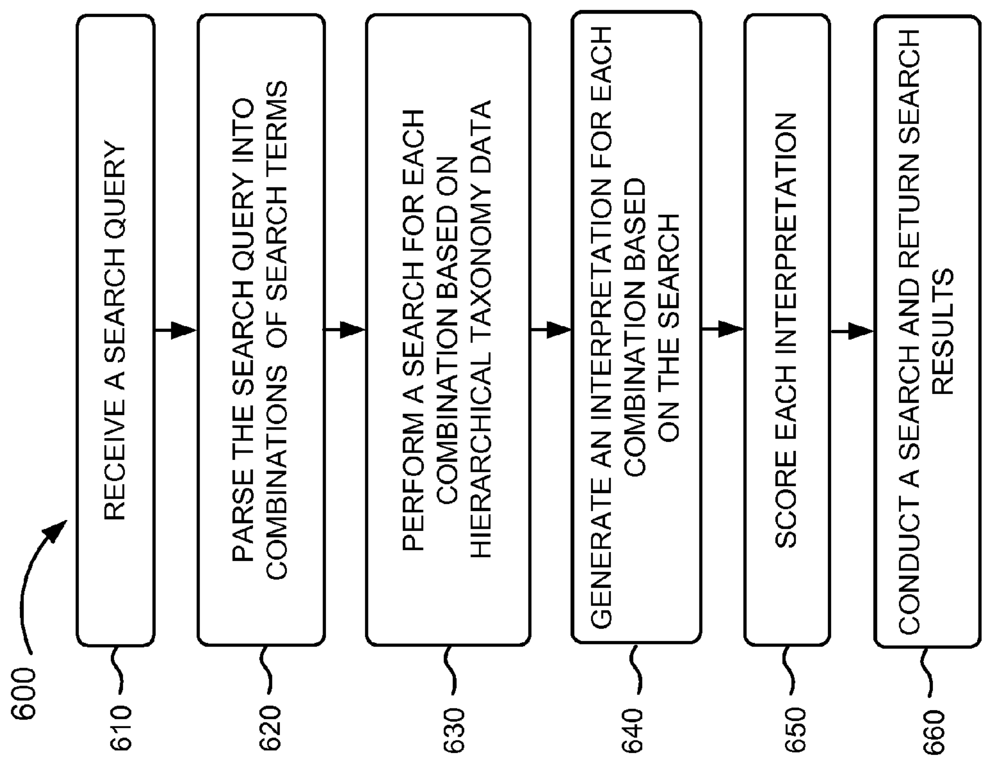

600
610
RECEIVE A SEARCH QUERY
620
PARSE THE SEARCH QUERY INTO COMBINATIONS OF SEARCH TERMS
630
PERFORM A SEARCH FOR EACH COMBINATION BASED ON HIERARCHICAL TAXONOMY DATA
640
GENERATE AN INTERPRETATION FOR EACH COMBINATION BASED ON THE SEARCH
650
SCORE EACH INTERPRETATION
660
CONDUCT A SEARCH AND RETURN SEARCH RESULTS

FIG. 6

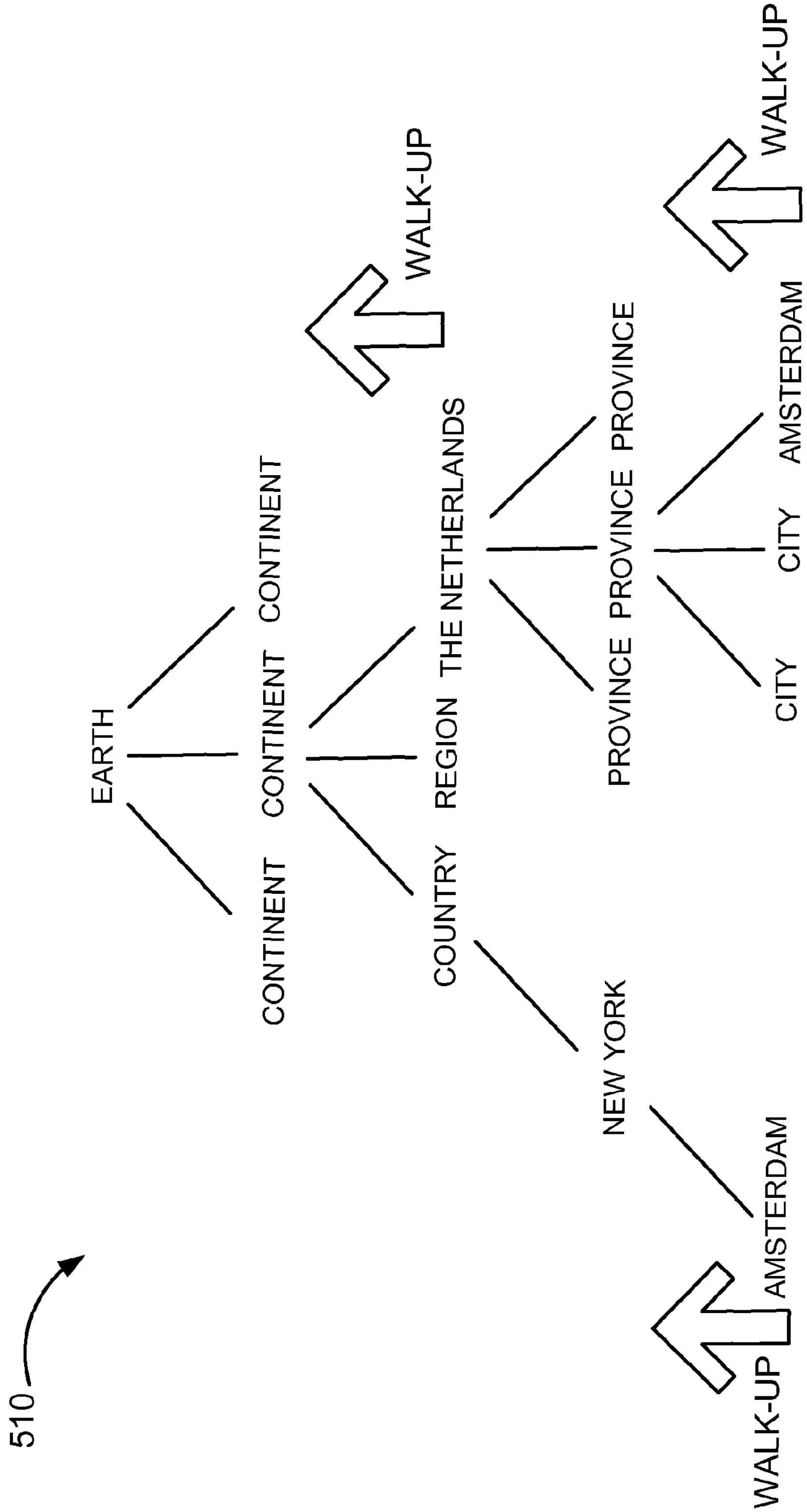

510
EARTH
CONTINENT
CONTINENT
CONTINENT
COUNTRY
REGION
THE NETHERLANDS
WALK-UP
NEW YORK
PROVINCE
PROVINCE
PROVINCE
PROVINCE
AMSTERDAM
CITY
CITY
AMSTERDAM
WALK-UP
WALK-UP

FIG. 7

INTERPRETING ADJACENT SEARCH TERMS BASED ON A HIERARCHICAL RELATIONSHIP

RELATED APPLICATION

This application is a continuation of U.S. patent application Ser. No. 13/452,179, filed Apr. 20, 2012 (now U.S. Pat. No. 8,745,028), which is a continuation of U.S. patent application Ser. No. 12/345,366, filed Dec. 29, 2008, which claims priority to U.S. Provisional Patent Application No. 61/016,916, filed Dec. 27, 2007, the disclosures of which are incorporated by reference herein in their entirety.

BACKGROUND

Search engines may implement various algorithms to identify Web pages relevant to search terms contained in a user's query. However, many search engines have limitations for providing relevant Web pages to a user because the search engines do not interpret the hierarchical meaning of the search terms. Rather, the search engine provides Web pages that merely include the search terms or variations of the search terms.

SUMMARY

According to one aspect, an computer-implemented method may include receiving, from a device, a search query that includes search terms, parsing the search terms into combinations of search terms, where each of the combinations includes one or more adjacent search terms, determining whether a hierarchical relationship exists for the one or more adjacent search terms of each of the combinations, generating one or more interpretations for each of the combinations based on whether the hierarchical relationship exists for the one or more adjacent search terms, performing a search based on at least one of the one or more interpretations to identify search results, generating a search result document containing the search results, and providing, to the device, the search result document.

According to another aspect, a computer-readable medium may include instructions that may be executable by one or more processors. The computer-readable medium may include one or more instructions for receiving a search query that includes search terms, one or more instructions for parsing the search query into combinations, where each of the combinations includes one or more of the search terms, one or more instructions for determining that a hierarchical relationship exists between adjacent search terms within one of the combinations having two or more search terms, based on hierarchical taxonomy data, one or more instructions for generating a meaning for the adjacent search terms of the one of the combinations in correspondence to a meaning associated with the hierarchical taxonomy data, one or more instructions for searching for search results based on the meaning associated with the one of the combinations, and one or more instructions for generating a search result document including the search results.

According to yet another aspect, a search engine may be implemented within one or more devices. The search engine may include a search component. The search component may receive a search query including search terms, parse the search query into combinations of one or more of the search terms, select a meaning for each of the one or more search terms included with each of the combinations based on a meaning of terms included with hierarchical taxonomy data, perform a search for search results based on the meaning associated with one of the one or more search terms of one of the combinations, and provide the search results.

According to still another aspect, a device may include means for receiving a search query that includes search terms, means for parsing the search query into combinations, where each of the combinations includes one or more of the search terms, means for selecting meanings for each of the one or more search terms included in each of the combinations based on a meaning of terms included with hierarchical taxonomy data, means for scoring each of the combinations based on the meanings associated with the one or more search terms, means for performing a search based on the meaning associated with one of the combinations to identify a search result, and means for providing the search result.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate one or more embodiments described herein and, together with the description, explain these embodiments. In the drawings,

FIG. **1** is a diagram illustrating systems and methods for performing a search;

FIG. **2** is a diagram of a network in which systems and methods described herein may be implemented;

FIG. **3** is diagram of a device which may correspond to the client and/or the server depicted in FIG. **2**;

FIG. **4** is a diagram illustrating components of the search engine depicted in FIG. **2**;

FIG. **5** is a diagram illustrating data that may be maintained by the search data depicted in FIG. **4**;

FIG. **6** is a flow chart illustrating a process for generating search results; and

FIG. **7** is a diagram illustrating an operation for determining whether a hierarchical relationship exists.

DETAILED DESCRIPTION

The following detailed description of the invention refers to the accompanying drawings. The same reference numbers in different drawings may identify the same or similar elements. Also, the following detailed description does not limit the invention.

Overview

One approach for interpreting search terms of a search query may be based on a tendency of a user to enter terms, which have a hierarchical relationship, adjacent to each other. FIG. **1** is a diagram illustrating systems and methods for performing a search. For example, assume that a user enters a search query that contains a set of search terms, and instructs his browser to provide the search query to a search engine. The search query may be received by search engine **105**. For example, assume that a portion of the search query includes the search terms "Zurich Switzerland." In this case, the search term "Zurich" is adjacent to the search term "Switzerland" within the search query. Additionally, there exists a hierarchical relationship between the search terms "Zurich" and "Switzerland." That is, "Zurich," a city, and "Switzerland," a country, have a hierarchical geographic relationship. It will be appreciated that although geographic search terms are representative of what may constitute a hierarchical relationship, hierarchical relationships exist in a broader spectrum of search terms. That is, search terms corresponding to objects, things, concepts, events, biological entities, plants, etc., may be entered as adjacent search terms that have a hierarchical relationship. In this regard, the phrase "hierarchical relationship," is intended to be broadly interpreted to include, for example, related instances of a category(s), a classification(s), etc., that have an order based on rank, class, grade, etc. For example, adjacent terms may have a parent-child relationship (e.g., class, sub-class, group-sub-group, genus-species, combination, sub-combination, etc.).

Search engine **105** may parse the search terms to form select, but not necessarily all, combinations of the search terms. A combination may include one or more search terms. A combination having more than one search term may include search terms that are adjacent to each other within the entered search query. For example, if a search query contains the search terms "oranges fruit Florida," search engine **105** would parse the search query into adjacent search terms "oranges fruit Florida," "oranges fruit," and "fruit Florida." However, search engine **105** would not parse the search query to form a combination containing the search terms "oranges" and "Florida," since "oranges" and "Florida" are not adjacent search terms. In this case, as previously mentioned, the search term "Zurich" is adjacent to the search term "Switzerland."

A combination may be interpreted based on a hierarchical scheme. For example, repository **110** may include hierarchical data. Search engine **105** may utilize the hierarchical data to interpret the adjacent search terms of a combination. For example, search engine **105** may compare the adjacent search terms to the hierarchical data. By way of example, the hierarchical data may include the terms "Zurich" and "Switzerland." Based on the comparison, search engine **105** may recognize that a hierarchical relationship (e.g., city, country) exists between the adjacent search terms "Zurich" and "Switzerland." Search engine **105** may interpret these adjacent search terms in correspondence to the hierarchical data.

Once the combinations of a search query are interpreted, search engine **105** may generate a relevance score for each interpretation. The relevance score may indicate a likelihood of matching a user's intended meaning of the search terms. For example, search engine **105** may utilize templates to score each interpretation. A template may include a pattern of hierarchical? terms that correspond to an order in which a user may formulate a search query. By way of example, a template related to a geographical taxonomy may correspond to the terms "city, state" or "state, country." In this example, search engine **105** may match a template "city, country" with the interpreted search terms "Zurich Switzerland." Search engine **105** may assign a score, that is associated with the matched template, to the interpretation of "Zurich Switzerland" as a "city, country" hierarchy.

Based on the relevance score of each interpretation, search engine **105** may search, for example, for Web pages that correspond to one or more of the scored interpretations. By way of example, search engine **105** may search Web pages that correspond to the interpreted meaning of "Zurich Switzerland" as having a city and country hierarchical relationship. The Web pages may be provided to, for example, a user and/or another search engine, as search results.

As a result of the foregoing, the search engine may provide more useful results because the search engine may interpret hierarchical meaning(s) associated with the search terms within the search query and search for results that correspond to the interpreted hierarchical meaning(s). Since the approach for interpreting search terms, scoring the search terms, conducting a search based on the meanings of the search terms, and providing search results have been broadly described, a more detailed description is provided below, as well as variations thereof.

Environment

FIG. **2** is a diagram illustrating an environment in which systems and methods described herein may be implemented. As illustrated, environment **200** may include a client **210**, a network **220**, and a server **230**. Server **230** may include a search engine **240**. Client **210** and server **230** may connect to network **220** via wired and/or wireless connections.

Client **210** may be, for example, a computer, a mobile phone, a personal digital assistant (PDA), and/or another type of communication device. Additionally, or alternatively, client **210** may be a program, a process, a fiber, or a thread running on a communication device and/or an object executable by a communication device.

Network **220** may be a local area network (LAN), a wide area network (WAN), a telephone network, such as the Public Switched Telephone Network (PSTN), an intranet, the Internet, any other type of network, and/or a combination of networks.

Server **230** may be, for example, a device of a collection of devices. Additionally, or alternatively, server **230** may be software running on a device or a collection of devices. Search engine **240** may be, for example, software to search and/or retrieve information based on a search request. For example, search engine **240** may service search requests from client **210**. Search engine **240** may be designed to return search results, such as Web pages, business listings, and/or maps based on the search request. In one implementation, the search results may be returned to client **210**. Additionally, or alternatively, the search results may be returned to another search engine (not illustrated).

Although FIG. **2** illustrates an environment, in other implementations, the environment may include fewer, additional, or different devices. For example, one client **210** and one server **230** have been illustrated as connected to network **220** for simplicity. In practice, there may be more clients **210** and/or servers **230**. Also, in some instances, client **210** may perform one or more functions of server **230** and/or server **230** may perform one or more functions of client **210**. Additionally, or alternatively, server **230** may be implemented in a distributed manner. For example, server **230** may be a back-end component that operates in parallel with another server(s) and/or search engine(s).

Example Device

FIG. **3** is a diagram of a device which may correspond to the client and/or the server depicted in FIG. **2**. As illustrated, device **300** may include a bus **310**, a processor **320**, a main memory **330**, a read only memory (ROM) **340**, a storage device **350**, an input device **360**, an output device **370**, and a communication interface **380**.

Bus **310** may include a path that permits communication among the elements of device **300**. Processor **320** may include a processor, microprocessor, or processing logic that may interpret and execute instructions. Main memory **330** may include a random access memory (RAM) or another type of dynamic storage device that may store information and/or instructions for execution by processor **320**. ROM **340** may include a ROM device or another type of static storage device that may store static information and/or instructions for execution by processor **320**. Storage device **350** may include a magnetic and/or an optical recording medium and its corresponding drive.

Input device **360** may include a mechanism that permits an operator to input information to the device, such as a keyboard, a mouse, a pen, voice recognition and/or biometric mechanisms, etc. Output device **370** may include a mechanism that outputs information to the operator, including a display, a printer, a speaker, etc. Communication interface **380** may include any transceiver-like mechanism that enables the device to communicate with other devices and/or systems. For example, communication interface **380** may include a mechanism for communicating with another device or system via a network, such as network **220**.

Device **300** may perform certain operations, as will be described in detail below, in response to processor **320** executing software instructions contained in a computer-readable medium, such as memory **330**. A computer-readable medium may be defined as one or more devices capable of storing instructions and/or data. For example, a computer-readable medium may correspond to a memory (e.g., main memory **330**), storage device **350**, or another type of device (e.g., a digital versatile disk (DVD), a compact disk (CD), etc.). The computer-readable medium may be implemented in a distributed manner (e.g., between two or more device **300***s*). The software instructions may be read into memory **330** from storage device **350**, or from another device via communication interface **380**. The software instructions contained in memory **330** may cause processor **320** to perform processes that will be described later. Alternatively, hardwired circuitry may be used in place of or in combination with software instructions to implement processes as described herein. Thus, implementations as described herein are not limited to any specific combination of hardware circuitry and software.

Although FIG. **3** illustrates a device **300**, in other implementations, device **300** may include additional, fewer, or different components. For example, device **300** may not include input device **360**. Additionally, or alternatively, in other implementations, device **300** may include an arrangement of components that are different than that depicted in FIG. **3**.

Search System

FIG. **4** is a diagram illustrating components of the search engine depicted in FIG. **2**. The term "component," as used herein, is intended to be broadly interpreted to include hardware or a combination of hardware and software. Search engine **240** may include a search component **410** and search data **420**.

Search component **410** may include one or more algorithms to perform various operations in accordance with the systems and methods described herein. For example, search component **410** may receive a search query, parse a search query, perform a search of search data **420** based on the search query, interpret the search query, score an interpretation(s) of the search query, and/or return a search result(s).

Search data **420** may include indexed data that may be utilized by search component **410** to interpret a search query. The indexed data may include data that is stored in an index by an indexer (not illustrated). For purposes of discussion, the indexed data will be described as relating to a geographical taxonomy. In this instance, the indexed data may be used for interpreting a search query as a reference to a place on Earth. It will be appreciated, however, that the indexed data may relate to other taxonomies (e.g., a business listing taxonomy, a biological taxonomy, etc.), instead of, or in addition to, a geographical taxonomy. In such instances, the indexed data may be used for interpreting a search query as a reference to a biological entity (e.g., an animal, a plant, etc.), interpreting a search query as a reference to a business (e.g., a name of a business), and/or in another manner according to the taxonomy implemented.

Search data **420** may also include data other than geographical data. For example, search data **420** may include an index of business listings, business information, Web pages, or other information (e.g., metadata) that may be associated with the geographical data. Search data **420** may include map data. The map data may be searchable by geographic location. In one implementation, the map data may include a graphical map, boundary information, and/or latitude and longitude coordinates. Search data **420** may also include user information. For example, user information may include the locale of a user from which the search query was sent.

Various data structures may be utilized in storing search data **420**. A portion of the indexed data may be stored in a data structure suitable for hierarchical data. For example, in one implementation, a tree data structure may be used to store the geographical data (i.e., corresponding to the geographical taxonomy). In other implementations, a different type of data structure (e.g., a linked list, etc.) may be utilized to store the geographical data. Other types of data structures (e.g., a table, etc.) may store other portions of the indexed data.

Although FIG. **4** illustrates components of search engine **240**, in other implementations, fewer, different, or additional components may be utilized. For example, search engine **240** may include a graphical user interface (GUI) to receive a search query and/or to present search results. Additionally, or alternatively, in other implementations, the arrangement of components may be different than the arrangement depicted in FIG. **4**. Additionally, or alternatively, search component **410** and/or search data **420** may be implemented in a distributed manner (e.g., between multiple search engines, devices (e.g., servers), etc.).

FIG. **5** is a diagram illustrating data that may be maintained in search data **420** depicted in FIG. **4**. As illustrated, search data **420** may include a tree **510**, a name table **520**, a bloom filter **530**, a triangular array **540**, a hit list **550**, and templates **560**. Each of these is a data structure that may be stored in a computer-readable medium.

Tree **510** may include indexed data (e.g., geographical data). Tree **510** may include a root node and parent/child nodes in correspondence to a hierarchical structure. The root of tree **510** may include, for example, the "Earth," and the remaining nodes may follow a hierarchical order, such as "continents," followed by "countries," "regions," "cities," "postal codes," and "points-of-interest." Depending on, for example, the location on Earth, a different hierarchical order of nodes may be utilized. For example, a portion of tree **510** that corresponds to the United States of America ("United States"), may include a hierarchical order of nodes, such as "country," "state," and "city." Additionally, or alternatively, tree **510** may include nodes, such as, for example, "street address," "global postal codes," and/or other nodes that correspond to an even more specific locale. For example, when search engine **240** may be utilized to perform a map search, tree **510** may include nodes having these more specific locales.

In addition to nodes corresponding to locations on Earth (i.e., geographical data), tree **510** may include nodes that do not include geographical data. For example, in some instances, a search term may include a name that corresponds to a place even though a user may not mean a place. For example, the search query may include the search terms "Orlando Bloom," a movie actor. Thus, while the search term "Orlando," may correspond to a city in Florida in the United States; the search terms "Orlando Bloom," may correspond to the movie actor. In this regard, search engine **240** may not interpret "Orlando" as a city since "Orlando" appears adjacent to "Bloom." Rather, search engine **240** may interpret "Orlando Bloom" as a person.

Tree **510** may also include attribute information. Attribute information may include, for example, the type of node, such as whether a node corresponds to a continent, country, city, or point of interest, a stand-alone value, a country stand-alone value, a relational value, map data, latitude and longitude information, boundary information, and/or other information (e.g., user location information).

The stand alone value may correspond to a value that represents an importance of a location in the context of the Earth. For example, the search terms "New York" may impart a significant degree of importance since "New York" may be considered well-known throughout the world. Thus, the stand-alone value for "New York" may be afforded a higher stand-alone value compared to another locale that may not be well-known throughout the world. The stand alone value may be based on, for example, the population of the location, well-known points of interest in the location, the size of the location, the number of searches relating to the location, the number of Web pages relating to the location, etc.

The country stand-alone value may correspond to a value that represents an importance of a location in the context of a country. For example, the search terms "Valencia, Canada" and "Valencia, Spain" may have different country stand-alone values since "Valencia" in Spain may be considered more important than "Valencia" in Canada. The country stand-alone value may be based on, for example, the population of the location, well-known points of interest in the location, the size of the location, the number of searches relating to the location, the number of Web pages relating to the location, etc.

The relational value may correspond to a value that represents an association between the search term and the name of the location. For example, the relational value may indicate whether the search term corresponds to a primary name, an official name, or a colloquial name. For example, a search term, such as "Massachusetts," may be considered a primary name. However, the search terms "The Commonwealth of Massachusetts" and/or the "State of Massachusetts" may be considered an official name. The search terms "Bay Area" may be considered a colloquial name for "San Francisco."

Map data may include a representation of an area. For example, as previously described, map data may include a graphical map. Latitude and longitude information may correspond to geographic coordinates. Boundary information may include map location information surrounding a center point relating to a locale.

Attribute information may be used by search engine **240** for, among other things, interpreting the search terms, scoring, and/or presenting information with the search results.

Name table **520** may include indexed data. For example, a name may correspond to a place, such as "Paris." Each name in name table **520** may include one or more pointers that point to all the items that it corresponds to in tree **510**. So, for example, the name "Paris," may have associated with it, a corresponding pointer that points to a city in France, a town in Texas, and a street in San Francisco in tree **510**. Thus, a name in name table **520** may have associated with it a pointer that points to multiple nodes in tree **510**. Conversely, a node of tree **510** may be pointed to by multiple pointers associated with multiple names of name table **520**. For example, name table **520** may include names, such as "New York," "New York City," and "Big Apple." In this instance, the pointers associated with these names may point to the same node in tree **510**. Name table **520** may include names that may not be places. For example, as previously described above, name table **520** may include the name "Orlando Bloom."

Bloom filter **530** may include, for example, prefixes to a longer name. For example, bloom filter **530** may include prefixes that may be an article, such as "the," or prefixes, such as "new," as in "New York." Thus, for example, these prefixes may not correspond to a place when considered in isolation; however, these prefixes may have a nexus to an adjacent search term, which, when taken together, may or may not correspond to a place.

Triangular array **540** may include select combinations of the search terms of a search query. The combinations of search terms may be thought of as a triangular array. In such an instance, each field of triangular array **540** may include a combination of the search terms. The number of combinations (i.e., fields of triangular array **540**) may be calculated by the formula

$$\frac{(N*(N+1))}{2},$$

where N corresponds to the number of search terms in the search query. So, for example, a search query containing four search terms may yield, when parsed, ten different combinations of the search query. As an example, assume that search query contains three search terms, "Pizza Zurich Switzerland." Triangular array **540** may include the following combinations: "Pizza Zurich Switzerland," "Zurich Switzerland," "Switzerland," "Pizza Zurich," "Zurich," and "Pizza." That is, triangular array **540** may include each combination of adjacent search terms (e.g., "Pizza Zurich Switzerland," "Zurich Switzerland," and "Pizza Zurich"), as well as individual search terms ("Pizza," "Zurich," and "Switzerland").

Hit List **550** may include a list of interpretations relating to the search terms of the search query that match name table **520** and/or tree **510**. These interpretations of hit list **550** may be scored based on a ranking algorithm included in search component **410**, as will be described below.

Templates **560** may include elements that provide a reference to score interpretations contained in hit list **550**. For example, templates **560** related to a geographical taxonomy may include elements corresponding to "city, state," "city, state, country," etc. In other words, the elements of a template **560** may include a pattern of terms that correspond to an order in which a user may formulate a search query.

Although FIG. **5** illustrates data, in other implementations, fewer, different, or additional data may be utilized. Additionally, or alternatively, and in other implementations, different data structures may be utilized. Further, search data **420** may include additional information not specifically described herein, such as location of the user, which may be used by search engine **240** for interpreting, scoring, and/or providing search results. Additionally, or alternatively, although attribute information has been described in relation to tree **510**, attribute information may be contained in other data structures, in combination among data structures in search data **420**, and/or elsewhere on server **230**.

FIG. **6** is a flow chart illustrating a process for generating search results. In one implementation, the blocks of FIG. **6** may be performed by server **230**. In another implementation, one or more blocks may be performed by a device other than server **230** or in combination with server **230**.

As illustrated, process **600** may begin with a search query being received from a user (Block **610**). For example, server **230** may receive a search query from client **210** via network

220. For example, a user of client **210** may provide a search query via a Web browser. In one implementation, search engine **240** may provide a graphical user interface (GUI) for a user to enter search terms. For example, the GUI may include one or more search boxes for entering a search query, and a search button to initiate the search. In one implementation, the search box may be a single text box in which the user may not be able to characterize the search terms (e.g., which part of the search query corresponds to, for example, a "where" part, a "who" part, a "what" part, etc.). Nevertheless, search engine **240** may interpret the search query in accordance with a hierarchical taxonomy based on the operations described herein. In other implementations, search engine **240** may not provide a GUI. For example, search engine **240** may be a backend component that receives a search query from another search engine.

For purposes of discussion, assume that a user would like to find restaurants. In this example, the user may enter a search query, such as "Restaurants Amsterdam the Netherlands" in the search box. The user may initiate the search by pressing the search button.

The search query may be parsed into combinations of search terms (Block **620**). For example, search component **410** may parse the search query into a combination(s) of search term(s) in the order in which the search term(s) were entered by the user. The combination may include one or more search terms. A combination having more than one search term may include search terms that are adjacent (e.g., search terms that appear next to each other in the order entered by the user). For example, search component **410** may select which search terms are adjacent based on the order of the search terms in the search query. In one implementation, the combinations may include each combination of adjacent search terms. In another implementation, adjacent search terms may include search terms that are not actually adjacent within the search query (e.g., search terms that are separated by stop-words). For example, a search query may include stop-words, such as "a" or "and," that may be discarded and/or ignored. In such instances, search terms may be considered adjacent by virtue of discarding or ignoring a stop-word.

As an example of parsing a search query, the search query "Restaurants Amsterdam the Netherlands" may be parsed into the following combinations: "Restaurants Amsterdam the Netherlands," "Amsterdam the Netherlands," "the Netherlands," "Netherlands," "Restaurants Amsterdam the," "Amsterdam the," "the," "Restaurants Amsterdam," "Amsterdam," and "Restaurants." That is, search component **410** may parse the search query "Restaurants Amsterdam the Netherlands" into every combination of adjacent search terms, as well as individual search terms.

In one implementation, search engine **240** may store the combinations in triangular array **540**. Additionally, or alternatively, search engine **240** may hash each search term to a size that minimizes collisions when searching and/or matching, for example, search terms with the information contained in name table **520** and/or tree **510**, as described below.

A search may be performed for each combination based on hierarchical taxonomy data to generate an interpretation (Block **630**). Search component **410** may conduct a search for each combination utilizing search data **420**. In one implementation, search data **420** may include data, such as name table **520**, which may provide an index to hierarchical taxonomy data, such as tree **510**. The hierarchical taxonomy data may include any hierarchical data, such as geographical, biological (e.g., plants or animals), business, objects, people (e.g., by profession), etc.

In one implementation, search component **410** may compare each combination of triangular array **540** to information in name table **520**. This process may be performed serially or in parallel. In such an instance, each search term of a combination may be matched with information in name table **520**. When a match between a search term of triangular array **540** and a name of name table **520** occurs, search component **410** may reference tree **510** based on the one or more pointers associated with the name of name table **520** that point to one or more nodes of tree **510**. A match between one or more search terms of a combination and a name contained in name table **520** may constitute a hit. For example, referring back to the search query "Restaurants Amsterdam the Netherlands," search component **410** may consider the combination "Restaurants Amsterdam." Limiting our discussion to geographical data, search component **410** may find a match between the search term "Amsterdam" and a name "Amsterdam" in name table **520**. Search component **410** may refer to tree **510** based on one or more pointers associated with the name "Amsterdam" in name table **520**.

In some instances, more than one search term of a combination may match one or more names in name table **520**. In these instances, search component **410** may determine whether the adjacent search terms of a combination have a hierarchical relationship by performing walk-ups in tree **510**.

FIG. **7** is a diagram illustrating an operation for determining whether a hierarchical relationship exists. For example, search component **410** may consider the combination "Amsterdam the Netherlands." Search component **410** may find a match between the search term "the Netherlands" and a name "the Netherlands" in name table **520**. Search component **410** may also find a match between the search term "Amsterdam" and a name "Amsterdam" in name table **520**. Search component **410** may refer to tree **510** based on one or more pointers associated with each name in name table **520**. In this instance, search component **410** may perform a walk-up from the node "Amsterdam" and a walk-up from the node "the Netherlands," as illustrated in FIG. **7**. As a result, search component **410** may determine that a hierarchical geographic relationship exists between the search term "Amsterdam" and the search term "the Netherlands." Additionally, if a pointer in name table **520** should point to other nodes in tree **510** called "Amsterdam," this hit, in one implementation, may be eliminated since adjacent search terms "Amsterdam" and "the Netherlands" have been joined. For example, as illustrated in FIG. **7**, a node "Amsterdam" in tree **510** may relate to a city in New York. Accordingly, a walk-up from this node will not intersect with the node "the Netherlands."

When conducting the search, search component **410** may also perform one or more other operations depending on the combination. For example, in one instance, search component **410** may consider the combination "Amsterdam the." While the search term "the" may not result in a hit, search component **410** may reference bloom filter **530**. Search component **410** may recognize the search term "the" as a preposition and/or as a connector, which may trigger search component **410** to consider the search term adjacent to the search term "the." Another example of such an instance relates to the search terms "New York." That is, search component **410** may recognize the search term "New" as a preposition and/or as a connector, based on bloom filter **430**, which may trigger search component **410** to consider the search term adjacent to the search term "New."

Given the multitude of possible search queries, variations to the above example may exist. For example, in some instances, the search query may contain a repetition of identical search terms, such as "Zurich, Zurich, Zurich." However, since a pointer in name table **520** may point to any node of tree **510** with the name "Zurich," search component **410** may determine a multitude of hierarchical relationships associated with these adjacent terms ranging from, for example, three separate and distinct search terms having no hierarchical relationship to three search terms having a hierarchical relationship.

Referring back to FIG. **6**, an interpretation may be generated for each combination based on the search (Block **640**). For example, search component **410** may generate an interpretation for each combination based on search data **420**, such as attribute information, name table **520**, bloom filter **530**, and/or tree **510**. For example, search component **410** may associate a meaning to the one or more search terms within each combination in correspondence to matches to search data **420**. In one implementation, the interpretations may be assembled in, for example, hit list **550**.

Each interpretation may be scored (Block **650**). As previously described, search component **410** may include a ranking algorithm to score each interpretation. Search component **410** may utilize templates **560** to score each interpretation. Additionally, search component **410** may assign a score to each interpretation based on one or more rules or heuristics. For example, the rules or heuristics may include considerations, such as, an order of the meaning of the search terms within a combination, the number of matched search terms within a combination, attribute information, etc.

For example, search engine **240** may compare various templates **560** to an interpretation. For example, a template **560**, such as a geo-template "city, country," may be compared to an interpretation associated with the search terms "Amsterdam the Netherlands." When an interpretation corresponds to template **560**, as in this example, the interpretation may be assigned a score associated with template **560**. In some cases, an interpretation may correspond to more than one template **560**; however, the scores may be different. For example, when a user resides in the United States, and an interpretation corresponding to template **560** (e.g., "city, state") and an interpretation corresponding to template **560** (e.g., "street, country") exist (i.e., both templates match the search terms), search component **410** may assign a higher score to the interpretation corresponding to template **560** (e.g., "city, state") than the interpretation corresponding to template **560** (e.g., "street, country"). In other words, template **560** corresponding to "city, state" may provide a higher score than another template **560** corresponding to "street, country" because the user in the United States is more likely (e.g., based on generalized user tendencies, rules, heuristics, etc.) to intend this order of meaning to these search terms.

Templates **560** may also be tailored to the user's location. For example, a user in the country of Thailand may describe a location in a search query in a different search term order and/or according to a different geographic hierarchy compared to a user in the country of the United States. Accordingly, search component **410** may apply templates **560** that correspond to the user's location. In one implementation, a user's geographic location information may be obtained from the user's network address (e.g., an IP address) and/or the domain from which the user may have accessed server **230**. Additionally, or alternatively, other information, such as attribute information may interrelate to the location of the user and impact the scoring of the interpretation.

Additionally, or alternatively, search component **410** may score an interpretation based on attribute information. For example, attribute information may be considered, such as whether a node of tree **510** corresponds to a continent, country, city, or point of interest, as well as a stand alone value, a country stand-alone value, and/or a relational value associated with the node.

Search component **410** may keep or discard an interpretation based on whether the score associated with an interpretation exceeds a threshold value. Additionally, or alternatively, search component **410** may select a certain number of interpretations based on a preset value.

A search may be conducted and search results may be returned (Block **660**). For example, search engine **240** may conduct a search based on one or more scored interpretations. That is, search engine **240** may conduct a search having knowledge of the hierarchical meaning of the search terms associated with the one or more interpretations to identify search results that are relevant to the meaning of the search terms. Search engine **240** may search the World Wide Web (WWW) and/or some other repository of information. Search engine **240** may transmit a Web page to the user that includes links to relevant search results. In other implementations, for example, search engine **240** may transmit the scored interpretations and/or the search results to another search engine for further processing. That is, for example, server **230** and search engine **240** may be a backend component that works in parallel with other servers and/or search engines (not illustrated in FIG. **2**) to interpret search queries.

In one implementation, descriptive information associated with the search result may also be provided. For example, when search engine **240** utilizes geo-coding to interpret a search query (i.e., to interpret the search query as a place or a geographical location), additional information, such as graphical map information may be provided. Additionally, or alternatively, a telephone number, address information, traffic information, weather, events occurring in a particular area, and/or driving directions, may be included with the search results.

Although FIG. **6** illustrates operations, in other implementations, fewer, additional, or different operations may be performed. For example, when a search query includes only one search term, block **620** may be omitted. Additionally, or alternatively, search engine **240** may perform walk-downs in tree **510** instead of walk-ups.

As described herein, search engine **240** may provide multiple interpretations of adjacent terms that may have a hierarchical relationship. Further, search engine **240** may provide for an expansive platform to interpret a search query based on any type of hierarchical taxonomy.

CONCLUSION

The foregoing description of preferred embodiments of the present invention provides illustration and description, but is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of the teachings. The search engine, as described herein, may utilize various taxonomies having a hierarchical schema, such as geographical taxonomies, business listing taxonomies, biological taxonomies, etc., as described above. Additionally, it will be appreciated that the search engine may be applicable to environments other than the Web or the Internet. That is, the search engine, described herein, may be utilized to search any type of repository of data.

In addition, while a series of blocks has been described with regard to the process illustrated in FIG. **6**, the order of the blocks may be modified in other implementations. Further, non-dependent blocks may be performed in parallel.

It will be apparent that aspects described herein may be implemented in many different forms of software, firmware, and hardware in the implementations illustrated in the figures. The actual software code or specialized control hardware used to implement aspects does not limit the embodiments. Thus, the operation and behavior of the aspects were described without reference to the specific software code—it being understood that software and control hardware can be designed to implement the aspects based on the description herein.

Even though particular combinations of features are recited in the claims and/or disclosed in the specification, these combinations are not intended to limit the disclosure of the invention. In fact, many of these features may be combined in ways not specifically recited in the claims and/or disclosed in the specification.

No element, block, or instruction used in the present application should be construed as critical or essential to the implementations described herein unless explicitly described as such. Also, as used herein, the article "a" is intended to include one or more items. Where only one item is intended, the term "one" or similar language is used. Further, the phrase "based on" is intended to mean "based, at least in part, on" unless explicitly stated otherwise.

The invention claimed is:

1. A method comprising:

determining, by a device, whether:

a first search term, of a search query, matches a first term at a first hierarchical level of a hierarchical taxonomy, and

a second search term, of the search query, matches a second term at a second hierarchical level of the hierarchical taxonomy,

the second hierarchical level being different from the first hierarchical level,

the search query being submitted by a user device;

determining, by the device, that the first search term and the second search term exist in a hierarchical relationship when:

the first search term matches the first term, and

the second search term matches the second term;

generating, by the device, an interpretation for a combination of the first search term and the second search term based on:

determining that the first search term and the second search term exist in the hierarchical relationship, and

a location associated with the user device;

determining, by the device, a score for the interpretation of the combination of the first search term and the second search term; and

identifying, by the device, search results based on the interpretation of the combination of the first search term and the second search term when the score exceeds a threshold,

the search results being provided for display.

2. The method of claim **1**, further comprising:

causing the search results to be provided to the user device for display.

3. The method of claim **1**, where the hierarchical taxonomy includes:

hierarchical data relating to business,

hierarchical data relating to events, or

hierarchical data relating to people.

4. The method of claim **1**, where identifying the search results includes:

identifying the search results based on:

a third search term of the search query, and

the interpretation of the combination of the first search term and the second search term.

5. The method of claim **1**, where the first search term and the second search term are adjacent search terms.

6. The method of claim **1**, where the hierarchical taxonomy includes:

hierarchical data relating to concepts, or

hierarchical data relating to objects.

7. A system comprising:

a device, comprising a memory, to:

receive a search query,

the search query including a plurality of search terms;

identify, based on a taxonomy, a hierarchical relationship between:

a first search term of the plurality of search terms, and

a second search term of the plurality of search terms,

the first search term and the second search term being adjacent search terms,

each of the first search term and the second search term being associated with a different level of the hierarchical relationship;

generate an interpretation for a combination of the first search term and the second search term,

the interpretation being generated based on the hierarchical relationship identified between the first search term and the second search term;

determine a score for the interpretation of the combination of the first search term and the second search term;

identify one or more search results based on the interpretation of the combination of the first search term and the second search term when the score exceeds a threshold; and

provide the one or more search results for display.

8. The system of claim **7**, where, when determining the score, the device is to:

determine the score for the interpretation based on a measure of popularity of the combination of the first search term and the second search term.

9. The system of claim **7**, where, when determining the score, the device is to:

determine the score for the interpretation based on a template and the interpretation.

10. The system of claim **9**, where the search query is received from a user device,

where the device is further to:

identify the template, from a plurality of templates, based on information identifying a location associated with the user device,

the plurality of templates identifying a plurality of hierarchical relationships.

11. The system of claim **7**, where, when identifying the hierarchical relationship, the device is to:

identify the hierarchical relationship based on a hierarchical taxonomy.

12. The system of claim **11**, where the hierarchical taxonomy includes:

hierarchical data relating to events, or

hierarchical data relating to people.

13. The system of claim **11**, where the hierarchical taxonomy includes:

hierarchical data relating to concepts,

hierarchical data relating to business,

hierarchical data relating to biological data, or

hierarchical data relating to objects.

14. The system of claim 7, where, when determining the score, the device is further to:

determine the score for the interpretation based on a measure of importance of one of the first search term or the second search term with respect to another one of the first search term or the second search term.

15. A non-transitory computer-readable medium storing instructions, the instructions comprising:

one or more instructions which, when executed by one or more processors, cause the one or more processors to receive a search query,

the search query including a plurality of search terms;

one or more instructions which, when executed by the one or more processors, cause the one or more processors to identify, based on a taxonomy, a hierarchical relationship between:

a first search term of the plurality of search terms, and

a second search term of the plurality of search terms,

each of the first search term and the second search term being associated with a different level of the hierarchical relationship;

one or more instructions which, when executed by the one or more processors, cause the one or more processors to generate an interpretation for a combination of the first search term and the second search term,

the interpretation being generated based on the hierarchical relationship identified between the first search term and the second search term;

one or more instructions which, when executed by the one or more processors, cause the one or more processors to determine a score for the interpretation of the combination of the first search term and the second search term;

one or more instructions which, when executed by the one or more processors, cause the one or more processors to identify one or more search results based on the interpretation of the combination of the first search term and the second search term when the score exceeds a threshold; and

one or more instructions which, when executed by the one or more processors, cause the one or more processors to provide the one or more search results for display.

16. The non-transitory computer-readable medium of claim 15, where the one or more instructions to generate the interpretation include:

one or more instructions to generate the interpretation based on a measure of popularity of the combination of the first search term and the second search term.

17. The non-transitory computer-readable medium of claim 15, where the one or more instructions to generate the interpretation include:

one or more instructions to generate the interpretation based on a measure of importance of one of the first search term or the second search term with respect to another one of the first search term or the second search term.

18. The non-transitory computer-readable medium of claim 15, where the one or more instructions to identify the one or more search results include:

one or more instructions to identify the one or more search results based on:

a third search term of the search query, and

the interpretation of the combination of the first search term and the second search term.

19. The non-transitory computer-readable medium of claim 15, where the search query is received from a user device, and

where the one or more instructions to generate the interpretation include:

one or more instructions to generate the interpretation based on a location associated with the user device.

20. The non-transitory computer-readable medium of claim 15, where the first search term and the second search term are adjacent search terms.

* * * * *